CNT-90

Timer/Counter/Analyzer

pendulum

- **250k measurements/s to internal memory, 750k stored measurements results**
- **Fast GPIB/USB bus speed, 5k meas/s – block mode**
- **Resolution: 12 digits/s (freq.), 100 ps (time), 0.001° (phase)**
- **14 digits display**
- **Frequency range: 400 MHz as standard. 3, 8, 15 and 20 GHz optional**
- **Ease-of-use: Multi-parameter display and graphical presentation of results**
- **Outstanding performance/ price ratio**

The Pendulum CNT-90 timer/counter/analyzer is an ultimate tool for measurement, analysis and calibration of Frequency, Time Interval or Phase. The CNT-90 is a high-performance counter with a fast measurement speed to 250,000 measurements/s, and time interval measurement resolution to 100 ps. The CNT-90 offers ease-of-use including graphical display and improved display and improved control over measurement at an outstanding price.

Leading Performance

The basic performance of the CNT-90 is leading compared to competition:

- With 5k measurement results transferred per second (block mode) via GPIB/USB, the CNT-90 can save you up to 90% testing time (and thus money) in test systems by increased throughput.
- High resolution is vital for R&D and production testing. CNT-90 meets this requirement with 100 ps single shot (time) or 12 digits/s (frequency). Obtained values are displayed with up to 14 digits.
- Modulation Domain Analysis is performed by capturing fast frequency changes with up to 250k Samples/s.
- For calibration purposes, the CNT-90 offers very high accuracy through stable internal OCXO time base, low systematic time interval A-B error and high resolution.
- Wide frequency range to 20 GHz covers most CW and burst microwave frequency measurement needs. There's no need to invest in a separate microwave counter.

Outstanding Performance/Price Ratio

The high performance CNT-90 timer/counter/analyzer outperforms all counters on the market (except Pendulum CNT-91), independent of measurement task.

- The graphic presentation of results – histogram, trend line, numerical statistics, modulation domain – provide a clearer understanding of random signal distribution and measurement changes over time – from slow drift to fast jitter, and modulation.
- Both USB and GPIB interfaces are standard. With USB you won't need to invest in a GPIB interface card for your PC. The GPIB operates in either SCPI/GPIB or 53131/53132 emulation mode, for plug-and-play replacement in existing ATE systems.
- Wide frequency range – to 20 GHz – offers microwave CW frequency measurements and very short burst measurements down to 40 ns.
- Menu-oriented settings reduce the risk of mistakes. Valuable signal information, given in multi-parameter displays, removes the need for other instruments like DVM's and Scopes.

Additional Technical Features

CNT-90 does not only offer high-performance, it is an ultimate tool for more specialized measurement. Some great features of the CNT-90 are:

- Zero dead-time technique and continuous time-stamping of trigger events. This feature allows correct measurements of Allan Deviation and is very valuable in mechanical (e.g. rotational

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encoder testing) and medical (e.g. nerve impulse/respiratory cycles) measurements where every single cycle must be measured.

- Limit qualifying a handy tool for making correct calculation of statistical parameters e.g. to verify the jitter of digital pulses that appear in discrete clusters (e.g. in CD-players or in HDB3-coded data). By setting limits you can isolate one cluster in the calculation.
- Hysteresis compensation in Time Interval measurements reduces trigger level error from the typical 15-20 mV found in most counters on the market today, down to typ. 2.5 mV. This means 6-8 times improved trigger precision in critical time interval measurements.

Battery Option

The CNT-90 has an optional battery pack with 90 Wh capacity, capable of mains-free operation for at least 4.5 hours.

In stand-by mode the battery pack can keep an OCXO warm and running for over 24 hours. Battery operation of a frequency counter/analyzer is valuable in three different applications:

- Mains-free operation in the field
- Transportation of high-stability OCXO to maintain stability, which gives instant use at destination without any warm-up time
- Battery backup acting as a built in UPS (Uninterrupted Power Supply)

Excellent Graphical Presentation

One of the great features of the CNT-90 is the graphical display and the menu oriented settings. The non-expert can easily make correct settings without risking costly mistakes.

The multi-parameter display with auxiliary measurement values such as Vmax/Vmin/Vp-p in frequency measurements, and frequency/attenuation/phase, eliminates the need for extra test instruments and provides direct answers to frequently asked questions, like "What is the attenuation and phase shift of this filter?"

Measurement values are presented both numerically and graphically. The graphical presentation of results (histograms, trends etc.) gives a much better understanding of the nature of jitter. It also provides you with a much better view of changes vs time, from slow drift to fast modulation (trend plot). Three statistical views of the same data set can be viewed: Numerical, Histogram and Trend. It is very easy to capture and toggle between views of the same data (see figure 4, 5 & 6).

When adjusting a frequency source to given limits, the graphic display gives fast and accurate visual calibration guidance.

Figure 1: Display showing phase value, frequency, attenuation Va/Vb, and auxiliary parameters.

Figure 4: Display showing different statistical parameters viewed at the same time.

Figure 2: Measure function selection menu, shown with measured results.

Figure 5: Display showing the trend (signal over time) of sampled data.

Figure 3: Input parameter setting menu shown with measured result.

Figure 6: The same result as in Figure 5, now displayed as a histogram.

Measuring Functions

All measurements are displayed with a large main parameter value and smaller auxiliary parameter values (with less resolution). Some measurements are only available as auxiliary parameters.

Frequency A, B, C

Range: *Input A, B:* 0.002 Hz to 400 MHz
Input C (option): Up to 3, 8, 15 or 20 GHz
Resolution:
12 digits in 1s measuring time (normal)
Aux. Parameter (A, B): Vmax, Vmin, Vp-p

Frequency Burst A, B, C (opt. 14/14B)

Frequency and PRF of repetitive burst signals can be measured without external control signal and with selectable start arming delay.
Functions: Frequency in burst (in Hz); PRF (in Hz)
Range: *Input A, B, C:* See Frequency spec.
Minimum Burst Duration: Down to 40 ns
Minimum Pulses in Burst:
Input A or B: 3 (6 above 160 MHz)
Input C: 3 x prescaler factor
PRF Range: 0.5 Hz to 1MHz
Start Delay: 10 ns to 2sec., 10 ns resolution
Aux. Parameter: PRF

Period A, B, C

Mode: Single, Average
Range:
Input A, B: 2.5 ns to 1000 sec. (single, average)
Input C (option): 10 ns down to 330, 125, 70 or 50 ps
Resolution: 100 ps (single); 12 digits/s (avg)
Aux. Parameter (A, B): Vmax, Vmin, Vp-p

Ratio A/B, B/A, C/A, C/B

Range: (10^{-9}) to 10^{11}
Input Frequency:
Input A, B: 0.1 Hz to 400 MHz
Input C (option): Up to 3, 8, 15 or 20 GHz
Aux Parameters: Freq 1, Freq 2

Time Interval A to B, B to A, A to A, B to B

Range: *Normal Calculation:* 0ns to $+10^{6}$ sec.
Smart Calculation: -10^{6} sec. to $+10^{6}$ sec.
Resolution: 100 ps
Min. Pulse Width: 1.6 ns
Smart Calculation: Smart Time Interval to determine sign (A before B or A after B)

Positive and Negative Pulse Width A, B

Range: 2.3 ns to 10^{6} sec.
Min. Pulse Width: 2.3 ns
Aux. Parameters: Vmax,Vmin, Vp-p

Rise and Fall Time A, B

Range: 1.5 ns to 10^{6} sec.
Trigger Levels: 10% and 90% of signal Vp-p
Min. Pulse Width: 1.6 ns
Aux. Parameters: Slew rate, Vmax, Vmin

Positive and Negative Duty Factor A, B

Range: 0.000001 to 0.999999
Freq. Range: 0.1 Hz to 300 MHz
Aux. parameters: Period, pulse width

Phase A Relative B, B Relative A

Range: -180° to +360°
Resolution: Single-cycle: 0.001° to 10 kHz, decreasing to 1° >10 MHz. Resolution can be improved via averaging (statistics)
Freq. Range: up to 160 MHz
Aux. Parameters: Freq (A), Va/Vb (in dB)

Vmax, Vmin, Vp-p A, B

Range: -50 V to +50 V, -5V to +5V
Range is limited by the specification for max input voltage without damage (see input A, B)
Freq. Range: DC, 1Hz to 300 MHz
Mode: Vmax, Vmin, Vp-p
Resolution: 2.5 mV
Uncertainty (5V range, typical):
DC, 1Hz to 1kHz: 1% +15 mV
1kHz to 20 MHz: 3% +15 mV
20 to 100 MHz: 10% +15 mV
100 to 300 MHz: 30% +15 mV
Aux parameters: Vmin, Vmax, Vp-p

Time stamping A, B, C

Raw time stamp data together with pulse counts on inputs A, B or C, accessible via GPIB or USB only.
Max Sample Speed:
See GPIB specifications
Max Frequency: 160 MHz
Timestamp Resolution: 70 ps

Input and Output Specifications

Inputs A and B

Frequency Range:
DC-Coupled: DC to 400 MHz
AC-Coupled: 10 Hz to 400 MHz
Impedance:
1MΩ // 20 pF or 50 Ω (VSWR ≤2:1)
Trigger Slope: Positive or negative
Max. Channel Timing Difference: 500 ps
Sensitivity: *DC-200 MHz:* 15 mVrms
200-300 MHz: 25 mVrms
300-400 MHz: 35 mVrms
Attenuation: x1, x10
Dynamic Range (x1): 30 mV p-p to 10 V p-p within ±5V window
Trigger Level: Read-Out on display
Resolution: 3mV
Uncertainty (x1): ±(15 mV + 1% of trigger level)
AUTO Trigger Level: Trigger level is automatically set to 50% point of input signal (10% and 90% for Rise/Fall Time)
AUTO Hysteresis:
Freq. range: 1Hz to 300 MHz
Time: Min hysteresis window (hysteresis compensation)
Frequency: One third of input signal amplitude
Analog LP Filter: Nominal 100kHz, RC-type.
Digital LP Filter: 1Hz to 50 MHz cut-off frequency
Max Voltage Without Damage:
1MΩ: 350 V (DC + AC pk) to 440 Hz, falling to 12 Vrms at 1MHz.
50 Ω: 12 Vrms
Connector: BNC

Input C (Option 10)

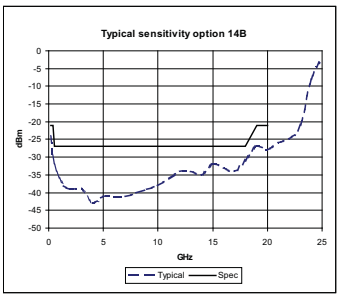
Operating Input Voltage Range opt. 10:
100 to 300 MHz: 20 mVrms (-21 dBm) to 12 Vrms
0.3 to 2.5 GHz: 10 mVrms (-27 dBm) to 12 Vrms
2.5 to 2.7 GHz: 20 mVrms (-21 dBm) to 12 Vrms
2.7 to 3.0 GHz: 40 mVrms (-15 dBm) to 12 Vrms
Prescaler Factor: 16
Impedance: 50 Ω nominal, VSWR <2.5:1
Max Voltage without Damage:
12 Vrms, pin-diode protected
Connector: Type N Female

Input C (Option 13)

Operating Input Voltage Range:
100 to 200 MHz: 100 mVrms to 7Vrms (typ.)
200 to 300 MHz: 40 mVrms to 7Vrms (typ.)
300 to 500 MHz: 20 mVrms to 7Vrms
0.5 to 3.0 GHz: 10 mVrms to 7Vrms
3.0 to 4.5 GHz: 20 mVrms to 7Vrms
4.5 to 6.0 GHz: 40 mVrms to 7Vrms
6.0 to 8 GHz: 80 mVrms to 7Vrms
Prescaler Factor: 256
Impedance: 50 Ω nominal, VSWR <2.5:1
Max Voltage Without Damage: 7Vrms
Connector: Type N Female

Input C (Option 14 and 14B)

Freq. Range: 0.25 to 15 GHz (opt. 14)
0.25 to 20 GHz (opt. 14B)
Operating input voltage range:
250 to 500 MHz: -21 to +27 dBm
0.5 to 15 GHz: -27 to +27 dBm
15 to 18 GHz: -27 to +27 dBm (Option 14B only)
18 to 20 GHz: -21 to +27 dBm (Option 14B only)
Prescaler Factor: 128



Impedance: 50 Ω nominal, VSWR <2.0:1
AM tolerance: > 90% within sensitivity range
Max Voltage Without Damage: +27 dBm
Connector: Type precision N Female

Rear Panel Inputs and Outputs

Reference Input: 1, 5, or 10 MHz; 0.1 to 5Vrms sine; impedance ≥1kΩ
Reference Output: 10 MHz; >1Vrms sine into 50 Ω
Arming Input:
Arming of all measuring functions
Impedance: Approx. 1kΩ
Freq. Range: DC to 80 MHz
Rear Panel Measurement Inputs:
A, B, C (opt. 11/90)
Impedance: 1MΩ//50 pF or 50 Ω (VSWR ≤2:1)
Connectors: SMA female for rear input C, BNC for all other inputs/outputs

Auxiliary Functions

Trigger Hold-Off

Time Delay Range: 20 ns to 2sec., 10 ns resolution

External Start and Stop Arming

Modes: Start, Stop, Start and Stop Arming
Input Channels: A, B or E-rear panel
Max Rep. Rate for Arming Signal:
Channel A,B: 160 MHz
Channel E: 80 MHz
Start Time Delay Range:

20 ns to 2sec., 10 ns resolution

Statistics
Functions: Maximum, Minimum, Mean, Δmax-Min, Standard Deviation and Allan Deviation
Display: Numeric, histograms or trend plots
Sample Size: 2 to 2 x 10^9 samples
Limit Qualifier: OFF or Capture values above/below/inside or outside limits
Measurement Pacing:
Pacing Time Range: 4µs to 500 sec.

Mathematics
Functions: (K*X+L)/M and (K/X+L)/M. X is current reading and K, L and M are constants; set via keyboard or as frozen reference value (X_0)

Other Functions
Measuring Time: 20 ns to 1000 sec. for Frequency, Burst, and Period Average. Single cycle for other measuring functions
Timebase Reference: Internal, External or Automatic
Display Hold: Freezes result, until a new measurement is initiated via Restart
Limit Alarm: Graphical indication on front panel and/or SRQ via GPIB
Limit Values: Lower limit, Upper limit
Settings: OFF or Alarm if value is above/below/inside or outside limits
On Alarm: STOP or CONTINUE
Display: Numeric + Graphic
Stored Instrument Set-ups: 20 instrument setups can be saved/recalled from internal non-volatile memory. 10 can be user protected.
Result Storage: Up to 8 measurements of max 32k samples can be stored in local memory for later downloading.
Display: Backlit LCD Graphics screen for menu control, numerical read-out and status information
Number of Digits: 14 digits in numerical mode
Resolution: 320*97 pixels

GPIB Interface
Compatibility: IEEE 488.2-1987, SCPI 1999, 53131A/53132A compatibility mode
Interface Functions:
SH1, AH1, T6, L4, SR1, RL1, DC1, DT1, E2
Max. Measurement Rate:
GPIB: 5k readings/s (block mode)
500 readings/s (individual GET trig'ed)
To Internal Memory: 250k readings/s
Internal Memory Size:
Up to 750k readings.

USB Interface
USB Version: 2.0 Full speed (11 Mbits/s)

Calibration
Mode: Closed case, electronic calibration, menu controlled
Cal. Frequencies: 0.1, 1, 5, 10, 1.544 and 2.048 MHz

Option 23/90 Battery Unit
Battery Type: Lilon, 90 Wh
External DC input: 10 to 18 V dc; max 6A
Operating temp. range: 0 to 40°C
Storage: -20 to +60°C, 1 month
-20 to +45°C, 3 months
-20 to +20°C, 1 year
Battery operating time (at 25°C):
ON: >4.5 hours
Stand-by: >24 hours
Charging: Automatically when AC or ext DC is connected
Battery status indicator:
On-screen with low battery warning
Weight: 2.3 kgs

General Specifications
Environmental Data
Class: MIL-PRF-28800F, Class 3
Operating Temp: 0°C to +50°C
Storage Temp: -40°C to +71°C
Humidity: 5%-95% (10°C to 30°C)
5%-75% (30°C to 40°C)
5%-45% (40°C to 50°C)
Altitude: 4,600 meters
Vibration: Random and sinusoidal according to MIL-PRF-28800F, Class 3
Shock: Half-sine 30G per MIL-PRF-28800F; Bench handling
Transit drop test: Heavy-duty transport case and soft carrying case tested according to MIL-PRF-28800F
Reliability: MTBF 30,000 hours (calculated)
Safety: EN 61010-1, pollution degree 2, meas cat I, CSA C22.2 No 1010-1, CE
EMC: EN 61326 (1997); A1 (1998), increased test levels according to EN 50082-2, Group 1, Class B, CE

Power Requirements
Max. configuration: 90 to 265 Vrms, 45 to 440 Hz, <40 W, <60 W if battery option

Dimensions and Weight
Width x Height x Depth:
210 x 90 x 395 mm (8.25 x 3.6 x 15.6 in)
Weight: Net 2.7 kg (5.8 lb),
Shipping app. 3.5 kg (app. 7.5 lb)

Time Base Options

Option model	STD	19/90	30/90	40/90
Time base type:	Standard	OCXO	OCXO	OCXO
Uncertainty due to: - Aging per 24h per month per year - Temperature variations: 0°C to 50°C 20°C to 26°C (typ. values)	 n/a <5×10^{-7} <5×10^{-6} <1×10^{-5} <3×10^{-6}	 <5×10^{-9} (1) <6×10^{-8} <2×10^{-7} <5×10^{-8} <2×10^{-8}	 <5×10^{-10} (1) <1×10^{-8} <5×10^{-8} <5×10^{-9} <1×10^{-9}	 <3×10^{-10} (1) <3×10^{-9} <1.5×10^{-8} <2.5×10^{-9} <4×10^{-10}
Short-term stability: τ =1s (root Allan Variance) τ =10 s	not specified	<1×10^{-10} <1×10^{-10}	<1×10^{-11} <1×10^{-11}	<5×10^{-12} <5×10^{-12}
Power-on stability: - Deviation vs. final value after 24 h on time, after a warm-up time of:	 n/a 30 min	 <1×10^{-7} 30 min	 <1×10^{-8} 10 min	 <5×10^{-9} 10 min
Typical total uncertainty, for operating temperature 20°C to 26°C, at 2σ (95%) confidence interval: - 1 year after calibration - 2 years after calibration	 <7×10^{-6} <1.2×10^{-5}	 <2.4×10^{-7} <4.6×10^{-7}	 <0.6×10^{-7} <1.2×10^{-7}	 <1.8×10^{-8} <3.5×10^{-8}

(1) After 1 month of continuous operation

Ordering Information
Basic Model
CNT-90: 400 MHz, 100 ps Timer/Counter including Standard Time Base
Included with Instrument: 3 years product warranty[1], line cord, user documentation on CD, and Certificate of Calibration
[1]The warranty period may be dependent on country.

Input Frequency Options
Option 10: 3 GHz Input C
Option 13: 8 GHz Input C
Option 14: 15 GHz Input C
Option 14B: 20 GHz Input C

Oscillator Options
Option 19/90: Medium Stability Oven Time Base; 0.06 ppm/month
Option 30/90: Very High Stability Oven Time Base; 0.01 ppm/month
Option 40/90: Ultra High Stability Oven Time Base; 0.003 ppm/month

Optional Accessories
Option 11/90: Rear Panel Inputs (replaces front panel inputs)
Option 22/90: Rack-Mount Kit
Option 23/90: Battery Unit
Option 27: Carrying Case - soft
Option 27H: Heavy-duty Hard Transport Case
Option 29/90: TimeView Modulation domain Analysis SW for CNT-90
Option 90/01: Calibration Certificate with Protocol; Standard oscillator
Option 90/06: Calibration Certificate with Protocol; Oven oscillator
Option 90/00: Calibration Certificate with Protocol; Hold-over frequency aging/week
Option 95/05: Extended warranty from 3 to 5 years
OM-90: Users Manual English (printed)
PM-90: Programmers Manual English (printed)
SM-90: Service Manual English
GS-90-EN: Getting Started English
GS-90-FR: Getting Started French
GS-90-DE: Getting Started German

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